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METROPOLITAN FRAGMENTATION, LAW ENFORCEMENT EFFORT AND URBAN CRIME

William C. Wheaton

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By

William C. Wheaton
Department of Economics
Center for Real Estate
MIT
Cambridge, Mass 02139
wheaton@mit.edu

"We don't [cooperate]. Law enforcement is the most turf-based institution in American. And when you have upwards of 19,000 separate police forces in a purposely decentralized law-enforcement environment, it's a lot of individual turf to protect". (William Bratton, 2002 Interview in Commonwealth Magazine).

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ABSTRACT

This paper investigates how local law enforcement agencies operate within a metropolitan area when there is an elastic flow of criminal activity between them. A model is developed in which a unilateral increase in local law enforcement effort has the effect of "scaring" away criminals as well as incarcerating them. Depending on the magnitude of these two effects, an MSA with many (small) agencies could wind up engaging in more or less effort – resulting in less or more crime. In a cross section of 236 US MSAs this model is tested with surprising results. Greater agency fragmentation leads to less effort, but also to less *crime*! This seemingly contradictory result is robust to many alternative specifications. The paper suggests that this result could happen either from some X-efficiency advantage by smaller agencies, or if criminals are *not* mobile and fragmentation better matches enforcement effort to local conditions.

I. Introduction.

Recently there has been renewed interest in how greater jurisdictional fragmentation within US metropolitan areas impacts the delivery of services and the distribution of tax burdens within "Tiebout" type competition. Rhode and Strumpf [2003] argues that over the last century, increased municipal fragmentation has not led to wider disparities in government services. Consistent with this, Epple and Sieg [1999] and Davidoff [2004] find surprisingly little income sorting – despite the increased opportunity for such that is afforded by extensive municipal fragmentation. Hoxby [2000] contributes most recently to this literature by showing that in a the existence of many smaller school districts results in both lower *average* school expenditures per pupil as well as improved *average* school test performance across those districts. She infers that school district "competition" generates greater efficiency and reduces the need for public expenditure.

This paper extends this line of research into the arena of local law enforcement. In the US, most law enforcement within metropolitan areas is conducted by town or municipal police departments. In addition, a small number of Country Sheriffs play a role particularly in any unincorporated portions of an MSA. Of course State police and the FBI may also contribute broader effort. How such a large number of local agencies cooperate and compete has been the subject of considerable discussion within the profession, but has not been well researched by economists.

Within the economics literature there has been much discussion over the causal relationships between aggregate criminal activity, sentencing and law enforcement (Leavitt [1996, 1997], Erlich [1981]. At the same time there has been little work on the flow of criminal activity across jurisdictions and the behavior of towns in the presence of such criminal "mobility". The recent papers by Helsley and Strange [1999], Freeman-Grogge-Sonstelie [1996] and Newlon [2001] each begins to examine how both local criminal intensity and enforcement effort impacts criminal utility and hence criminal mobility across jurisdictions.

This paper extends the latter group of papers by developing a full Nash Equilibrium model of local law enforcement effort and criminal flows. Local jurisdictions expend funds to increase arrests which in turn reduce local criminal activity. The

effectiveness of arrests on reducing local activity is a central determinant of the expenditure decision. A total pool of regional criminals – that are not incarcerated - distributes itself across jurisdictions to achieve a common level of "utility". Local arrest effort thus both reduces the local share of this pool that the town receives as well as reducing the regional pool with a typical "incarceration" impact. Within this framework, "smaller" jurisdictions have less incarceration impact on the regional pool, but greater "deflection" effect on the share of the pool operating in their jurisdiction. The magnitude of these two effects determines whether a larger number of "smaller" jurisdictions face more or less incentive to expend effort. MSA crime levels move inversely to Nash Equilibrium effort levels.

Empirically, the paper develops an extensive cross section data base for 236 MSA in 1997 – a year in which all local law enforcement agencies are surveyed. Included is data on MSA criminal activity, the number of agencies and their effort levels (wages and expenditure). Since the number of agencies has changed little between (5-year) surveys, the paper takes the view that fragmentation is largely "historic" and hence exogenous with respect to current criminal activity. Using a wide range of reduced form equations, it turns out that MSA's with a larger number of agencies clearly spend less in aggregate on law enforcement effort. Surprisingly, such MSAs also have *less* crime. These results withstand numerous empirical specifications.

These results are inconsistent with the model developed wherein fragmentation impacts the demand for law enforcement effort, which then has the expected impact on aggregate criminal activity. Rather, the results are more consistent with the type of argument presented by Hoxby [1999] in which fragmentation somehow increases the efficiency of an agency which then reduces the need (and demand) for resources.

The paper is organized as follows. Sections II through IV develop the model and its predictions about the impact of metropolitan fragmentation on law enforcement effort and crime. Section V describes the data and then Section VI presents a range of reduced form equations as well as an "assignments" of instruments to estimate a structural model. These results confirm the reduced form estimates. Section VII concludes with some suggestions about how to interpret the empirical results.

II. Modeling the demand for local Law Enforcement and the local supply of criminal activity.

We begin with an MSA composed of N communities (subscripted with i,k, or n) each of which generates arrests at the rate a_i by expending resources, where the unit cost of an arrest is K. Towns internally are composed of representative agents who need not be the same across towns. Each town (i) has h_i such agents with private incomes of y_i. Thus MSA population is $H=\sum h_i$ and aggregate income is $Y=\sum y_i h_i$. Aggregate MSA expenditure on arrests is $\sum Ka_i h_i$.[1]

The flow of crime *per local resident* in each town is noted as c_i, and crime and criminals are assumed to be equal. Each available criminal commits one crime in one town. Thus the number of criminals operating in each town is $c_i h_i$ and the regional pool of criminals committing crimes (those not incarcerated) is $\sum c_i h_i$. This latter summation is equivalently equal to the aggregate flow of crime.

Towns or their agents, select an arrest rate, to maximize the simple utility function (1), which yields the first order condition (2).

$$\text{maximize } (a_i)\text{: } U(y_i - a_i K, c_i) \tag{1}$$

$$- U'_{1i} K + U'_{2i} dc_i/da_i = 0 \quad \text{or} \quad U'_{2i}/ U'_{1i} = K/(dc_i/da_i) \tag{2}$$

$$\text{where: } U'_{1i} = \partial U/\partial x_i \geq 0, \quad U'_{2i} = \partial U/\partial c_i \leq 0$$

For convexity it is generally assumed that $U''_{1i} < 0$ and $U''_{2i} < 0$ (increasing marginal disutility of crime). This yields an upward sloping schedule between criminal activity and law enforcement effort – at the town level – conditional on the "effectiveness" of arrests on reducing crime dc_i/da_i. As a consequence of convexity, a greater derivative dc_i/da_i will lead the town to spend *more* and increase arrests.

With each town using the marginal condition (2), we get a system of N "demand" equations that are conditioned on the values of dc_i/da_i. To complete the system, we need to specify the criminal flow equations or the "supply" side of the market and then from these derive the "effectiveness" derivatives.

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[1] We use the convention of having an *un-subscripted* summation $\sum$ refer to the full set of towns. When there are two subscripts within the summation, that being summed is indicated under the summation sign.

The MSA has a total pool of potential criminals which is C and we assume that this pool is fixed (there is no inducement into or out of crime). Following Leavitt [1996] these criminals are either incarcerated or committing crimes. When arrested, criminals serve a common MSA level sentence length of L. In equilibrium, there is a steady state flow condition between incarceration releases and arrests – aggregated across towns. This is expression (3) below.

$$C = \sum c_i h_i (1+ a_i L), \quad \text{from } [C-\sum c_i h_i]/L = \sum a_i c_i h_i \tag{3}$$

Following Helsley and Strange [1999] we assume that the movement of criminals across towns is perfectly elastic with respect to the net returns (or utility) that they obtain from such activity. The net returns to crime committed in each town V will depend negatively on that town's arrest rate and also negatively on its criminal density c_i. In trying to explain the existence of crime "hot spots", Freeman-Grogger-Sonstelie [1996], assume that criminals can "mask" each other and reduce their probability of arrest. Holding arrests fixed, however, more criminals reduce the gains from criminal activity to each individual criminal. With perfect criminal mobility, the returns to crime must be equal across towns:

$$V(a_i, c_i) = V^* \text{ over all } (i=1,N) \tag{4}$$
$$V'_{1i} = \partial V/\partial a_i \leq 0, \quad V'_{2i} = \partial V/\partial c_i \leq 0$$

Equation (3) when combined with the set of N equations (4) determines the spatial pattern of crime (c_i) and criminal returns V^* – given the spatial pattern of arrests a_i. The ratio V'_{1i}/ V'_{2i} determines how many fewer criminals have to operate in a town as that town increases its arrest effort – to keep the returns to crime fixed.

In order to close the system we need to specify how levels of c_i and a_i determine the "effectiveness" derivative dc_i/da_i.

III. Determination town arrest effectiveness: dc_i/da_i.

We assume that each town understands the criminal flow equations (3) and (4) and plays a Nash game. Thus each assumes that other town's efforts a_k are fixed as it adjusts a_i and determines its own effectiveness. Totally differentiating (3) and (4) with respect to a_i we get the equations in (5):

$$h_i(1+a_iL)\,dc_i/da_i = -\,c_iLh_i - \sum_{k\neq i} dc_k/da_i\, h_k(1+a_kL) \qquad (5)$$

$$V'_{1i} + V'_{2i}\,dc_i/da_i = dV^*/da_i \quad \text{or,} \quad dc_i/da_i = \frac{dV^*/da}{V'_{2i}} - V'_{1i}/V'_{2i} \;<>\; 0$$

$$V'_{2k}\,dc_k/da_i = dV^*/da_i \quad \text{or,} \quad dc_k/da_i = \frac{dV^*/da_i}{V'_{2k}} \;<>\; 0$$

Solving for dV^*/da_i.

$$dV^*/da_i \sum \left[\frac{h_n(1+a_nL)}{V'_{2n}} \right] = -\,c_iLh_i + (V'_{1i}/V'_{2i})h_i(1+a_iL) \qquad (6)$$

On the left hand of (6), the summation term is negative and so dividing through reverses all signs on the right hand side. On the right hand side, the first term is negative and represents the "incarceration" effect. By reducing the total MSA pool of criminals increased arrests in one town improve criminal utility because MSA wide criminal density is reduced. The second term on the RHS is positive (hence its impact on V^* is negative) and it represents a "deflection" effect. By increasing arrests, a town "scares" criminals to other towns. In those towns, where arrests are fixed, the deflection effect tends to increase criminal density and hence reduce V^*.

If V'_{1i}/V'_{2i} is "large" (positive) then there is much "deflection" of criminals to other towns when town (i) expands arrest effort. This makes it likely that $dV^*/da_i < 0$ and this implies $dc_k/da_i > 0$. On the other hand if V'_{1i}/V'_{2i} is "small" then there is little "deflection" of criminals to other towns when town (i) expands effort, and in this case the incarceration effect dominates with $dV^*/da_i > 0$, and $dc_k/da_i < 0$.

Combining (5) and (6) we solve for dc_i/da_i and get (7) below:

$$dc_i/da_i \sum_n [h_n(1+a_nL)(V'_{2i}/V'_{2n})] = -c_iLh_i - \sum_{k\neq i} (V'_{1i}/V'_{2k})h_k(1+a_kL) \tag{7}$$

The left hand side summation term is positive, and on the right hand side, both terms are negative. Hence dc_i/da_i is always signed negative as one would expect.

IV. Impact of town size on the arrest effectiveness.

To better understand the role of town size we can suppose there are two towns: "our" town 1 and "others" 2. From (7) this simplification produces:

$$dc_1/da_1 = \frac{-c_1L\,h_1 - h_2(1+a_2L)(V'_{11}/V'_{22})}{h_1(1+a_1L) + h_2(1+a_2L)(V'_{21}/V'_{22})} \tag{8}$$

Now as h_1 goes to zero, dc_1/da_1 approaches the deflection term (V'_{11}/V'_{21}). In effect a "tiny" town has no effect on *metropolitan wide* incarceration. At the other extreme as h_2 approaches zero, dc_1/da_1 equals the incarceration term $-c_1L/(1+a_1L)$ since deflection away from a very "large" town becomes effectively impossible.

In equilibrium we assume Nash symmetry and this simplification implies: $c_n = c$, $h_n = h = H/N$, $a_n = a$, $V'_{2n} = V'_2$ and $V'_{1n} = V'_1$. With this the equations in (5) reduce to those in (9)

$$dV^*/da_i = \frac{V'_2}{N}\left[\frac{-cL}{(1+aL)} + \frac{V'_1}{V'_2}\right] \tag{9}$$

$$dc_k/da_i = \frac{1}{N}\left[\frac{-cL}{(1+aL)} + \frac{V'_1}{V'_2}\right]$$

$$dc_i/da_i = \frac{1}{N}\left[\frac{-cL}{(1+aL)} - \frac{V'_1(N-1)}{V'_2}\right]$$

Clearly as N increases, the magnitude of both dV^*/da_i and dc_k/da_i is reduced, whatever its sign is and N does not impact that sign. On the other hand, as N increases, dc_i/da_i can become smaller or larger. To see this, upon further differentiation we get:

$$d^2c_i/da_idN = \frac{1}{N^2}\left[\frac{cL}{(1+aL)} - \frac{V'_1}{V'_2}\right] \qquad (10)$$

In (10) if the deflection effect is large, then greater metropolitan fragmentation (a larger N) increases the negative value of town arrest effectiveness and hence town arrest effort will increase. Effectively, a large number of small town are encouraged to spend more because as each acts unilaterally they "think" they are solving crime by "scaring" away criminals! Conversely, if the deflection effect is nil then with a larger N, a smaller incarceration effect reduces effectiveness and town arrest effort will diminish. Here, a large number of small towns get "discouraged" because on their own margin, increased effort seems to do nothing to reduce aggregate crime.

The empirical implications of the model are quite straightforward. If the deflection effect (V'_1/V'_2) is large, then in an MSA with many smaller jurisdictions, each should face a larger value for dc_i/da_i, and hence spend more on law enforcement effort. On the other hand if the deflection effect (V'_1/V'_2) is nil, then in an MSA with many smaller jurisdictions, each should face a smaller value for dc_i/da_i, and hence spend less on law enforcement effort.

In this model, the impact of MSA fragmentation on spending should effectively identify the magnitude of the deflection versus incarceration effect. Presumably MSA crime rates move inversely to aggregate crime effort with respect to the number of jurisdictions (ceteris paribus).

V. Cross-Section Data.

The primary data base of the empirical section of the paper is a cross-section of 236 US Metropolitan areas. For each of these areas we obtained a wide range of data on population, income, poverty, the age distribution, climate, etc (see below). This is slightly less than the total number of US metro areas because some data was occasionally missing, and as well, this data had to be matched to the list of data from the LEAA and FBI.

For criminal activity, we used the FBI uniform crime reports for 1997, aggregated into two categories: property crime (Burglary, larcenry, theft) and violent crime (assault, rape, murder, robbery). This data is often used despite widespread misgivings about the

under-reporting of crime. So called "Victimization Surveys" simply would not have provided us with enough metropolitan areas. The FBI data was available from 16000 agencies covering 253 MSAs. The annual incidence of property crime in these MSA ranges from 5 per thousand to 101 per thousand. Violent crime ranges from 0.3 per thousand to 18 per thousand.

The year 1997 was chosen because every so often, the LEAA conducts a "Census" of all law enforcement agencies in the United States. This is not a regular survey and was last done in 1997 and involved approximately 24000 agencies. An agency must employ more than 5 people to be interviewed. This survey is the *only national systematic* source of data on police expenditures. Included is limited information on total expenditures, and total employees, but with no evaluation of FTE (full time equivalency). Many enforcement employees are paid hourly and are part time, so this is a shortcoming of the census. This data was aggregated to the MSA level but excluded expenditures made by State and Federal agencies operating in the MSA. In effect it included only local municipal police, County Sheriffs and any enforcement activity by public authorities (e.g. transit police). The census shows that expenditures per capita for law enforcement ranges from $33 to $296 across the 236 metropolitan areas.

To supplement the LEAA data, we also gathered information from the government's employment survey of average wages and earnings - for those employees in local public law enforcement agencies (occupational categories 61005, 63001, 63014)) in the year 1997. In our data, average hourly wages (across all law enforcement occupations) range from low's of around $9.50 in some Southern areas to as high as $32.00 in a few large Metropolitan areas. Dividing this into the agency's total budget we get some measure of the real resources (e.g. "hours") that each area puts into law enforcement.

Table 1 summarizes the data obtained and divides the variables into two categories: those most likely to represent demand side instruments and shift local law enforcement expenditure and those most likely to be supply side instruments and shift the supply of criminal activity. This division of course is far from certain, and we will discuss this in more detail in the following section.

Table 1: Variables, definitions

Variable Name	Description
Avepolice	Average MSA police expenditure per capita
Aveex	Avepolice/wage
Aveprpcrm	MSA property crime rate
Aveviocrm	MSA violent crime rate
Demand:	
Wage	Average MSA hourly wage of all local police employees
Perinc	MSA per capita income
Edu	Average years of education of the MSA population over 24
Landarea	Land area within MSA definition.
Supply:	
Povrat	Fraction of MSA household below the "poverty" line
Unemp	MSA unemployment rate
Black	Fraction of MSA population of the Black race.
Hispanic	Fraction of MSA population of Hispanic origin
Popover24	Fraction of MSA population over the age 24
Coolday	Average number of days/year "requiring air conditioning"
Joint:	
Criagency	Number of MSA law enforcement agencies.
Pop	MSA population

VI. Cross-Section Results.

In each of the next three tables, we present a range of regression results. The first three columns are reduced form equations that regress real police resources and crime rates against a growing list of exogenous variables that might reasonably be expected to shift both the demand for law enforcement expenditures and the supply of property and violent crimes. As more variables are added between columns 1 and 2, fits tend to improve but colinearity sometimes takes a toll on significance. An important distinction between columns 2 and 3 is whether to include the average police wage rate of an MSA as another "exogenous" variable. The simple correlation of this variable with per capita income is quite high (.86) and so it can be argued that these wage rates largely move with MSA income and cost of living. As such they would not represent endogenous movements up a local labor supply curve. Still we present all results with and without the wage variable.

In columns 4 and 5 we offer up a set of IV equations where the exogenous variables have been assigned to the demand or supply side according to Table 1. On the demand side we use education level as a taste variable distinct from per capita income which represents ability to pay. This runs contrary to the recent argument by Lochner and Moretti [2004] that education can be an important supply shifter as well. The wage rate obviously impacts expenditures or alternatively will negatively impact real resources. Land area has been argued by several authors to again impact the cost and difficulty of supplying law enforcement resources (Newlon [2001]). Socio economic, racial, demographic, and poverty variables are assigned to the supply (crime generating) equation. The assumption is that poor economic conditions together with a young minority population will all increase crime. There has been substantial evidence that crime is also easier to commit is warmer climates and at warmer times of the year and so we include the number of "cooling days" (Jacob and Lefgren [2003]). We allow MSA size and the number of crime agencies to shift both schedules.

In the first column of Table 2 we present a basic equation using just 5 instruments. All instrument signs are as expected. Per capita income increases expenditure as also is true of larger MSAs with higher poverty and minority concentration. Presumably these latter effects occur as these factors increase crime generation which then increases expenditure demand.

In the second column we expand the instruments. Here the only unexpected result is the unemployment variable which one would suspect should be associated with higher expenditure to counteract its impact on crime generation. Fit improves, but the significance of the minority variables suffers.

In the third column the addition of law enforcement wages provides a very significant boost to explaining real resource outlays – with the expected sign. We tend to regard this variable as exogenous, but it certainly could be argued that as resources increase, wages do as well while working up a regional labor supply curve.

Table 2: Police resources per capita (Aveexx)

Variable	1	2	3	4	5
estimation	OLS	OLS	OLS	IV[1]	IV[2]
constant	6.9e-04	6.9e-04	-5.1e-04	-1.2e-03**	-2.4e-04
perinc	9.7e-08**	1.3e-07**	2.2e-07**	2.3e-07**	7.7e-08**
pop	1.6e-10**	1.8e-10**	2.2e-10**	1.9e-10**	3.9e-11
povrat	5.5e-03**	7.8e-03**	5.0e-03**		
criagency	-6.4e-06**	-5.8e-06**	-7.2e-06**	-4.3e-06**	-2.9e-06*
Edu		6.2e-03**	6.0e-03**	1.0e-02**	8.3e-03**
Black	1.7e-05**	7.2e-06	1.5e-05*		
Hispanic		3.1e-07	8.5e-06		
Landarea		1.8e-08	1.3e-08	5.5e-09	1.4e-08
Unemp		-1.2e-04**	-4.6e-05*		
Popover24		1.5e-05	5.8e-06		
Coolday		2.3e-07**	9.6e-08*		
Wage			-5.1e-08**	-6.2e-08**	
Aveprpcrm				3.2e-02**	
Aveviocrm					1.7e-01**
R2	.16	.27	.36	.40	.15

** denotes significant at 5% N = 236

* denotes significant at 10%

[1] Instruments are full list of exogenous variables [2] Instruments exclude wage

In columns 4 and 5 there are two "structural" demand equations, using the supply instruments for identification. The equations have the expected sign with respect to the instrumented crime variables, and either property or violent crimes are significant. Violent and property crime are very highly correlated, however, so while each works well in these equations, when included together they become insignificant.

What is most interesting is that in all of these equations, the impact of greater jurisdictional fragmentation is clearly negative and always significant. If we believe the model in the previous sections of the paper, this suggests that with more jurisdictions in an MSA, each tends to spend less because their impacts on regional incarceration become diminished. The fact that this result shows up in the "structural" equation as well helps to reinforce the conclusion that the "deflection" effect is weak and dominated by the incarceration effect.

Table 3: Property crime per capita (Aveprpcrm)

Variable	1	2	3	4	5
estimation	OLS	OLS	OLS	IV[1]	IV[2]
constant	2.3e-02**	6.9e-02**	5.3e-02**	6.2e-02**	6.1e-02**
perinc	3.7e-07	7.4e-07	-1.9e-07		
pop	3.6e-09**	1.9e-09*	1.4e-09	1.8e-10**	1.7e-10**
povrat	7.2e-02**	3.7e-02	4.6e-02	4.9e-03	-3.9e-03
criagency	-1.3e-04**	-9.4e-05**	-7.8e-05**	-1.0e-04**	-8.9e-05**
Edu		-4.7e-02*	-4.6e-02*		
Black	4.0e-04**	2.4e-04**	2.5e-04**	4.3e-04**	4.0e-04**
Hispanic		-1.7e-06	-1.7e-06	1.7e-04*	1.5e-04
Landarea		6.9e-08	1.4e-07		
Unemp		3.4e-04	-1.8e-04	-1.4e-04	7.6e-05
Popover24		-6.7e-04**	-4.8e-04**	-2.9e-04*	-3.9e-05*
Coolday		5.5e-06**	6.8e-06**	6.1e-06**	6.0e-06**
Wage			4.0e-07**		
Aveexx				-4.0e-00**	-1.6e-00
R2	.23	.32	.35	.22	.30

** denotes significant at 5% N = 236

* denotes significant at 10%

[1] Instruments are full list of exogenous variables [2] Instruments exclude wage

In Table 3, we present the results for MSA property crime rates. In the first equation, all variables have the expected signs except for per capita income although per capita income is not significant. In the second column, again most variables have the expected signs (if their impacts are as defined in Table 1), but the poverty variable fades into insignificance. Cooling days, the age distribution and education seems to be the variables adding explanatory power.

In column 3, the addition of police wage rates also has the expected sign. If wages are an exogenous demand shifter – as in Table 2 – then higher wages should lead to less real resources which then should increase crime in the reduce form. This is exactly what seems to happen. This view gets somewhat reinforced by column 4 and 5 where in the "structural" crime equations, police resources have the expected negative sign.

The most interesting result is that throughout all of these equations the number of law enforcement agencies has a consistent and significant *negative* impact on crime. This

result is simply *inconsistent* with its impact in Table 2 on law enforcement resources – at least if the model is sections II through IV is to be believed.

In Table 4 we get quite similar results with the violent crime rate. In the first two columns, all variables have the expected signs with the exception of per capita income, which in this case is significantly positive. The results in column 3 perhaps provide an explanation for this. When the police wage rate is included, per capita income becomes insignificant and the wage rate has the expected sign – raising the crime rate by presumably reducing real resources.

The "structural" violent crime equations also work, in the sense that the impact of greater police resources is negative whenever significant. The other exogenous variables continue to suggest that structurally, larger MSAs with young minority populations, in warmer climates and experiencing economic poverty or stress have more violent crime.

As in the property crime equations, every specification in table 4 has the number of law enforcement agencies reducing the overall MSA crime rate, and at high significance levels. This is true whether the equation is a reduced form or a "structural" supply equation.

Considerable experimenting was undertaken with the assignment of instruments in the "structural" models reported in the last two columns of Tables 2-4 and described in Table 1. While the assignment of some instruments may seem obvious (wage to the demand side, climate to supply), other's are less clear. The assignment used and reported in the tables reflects that which tended to produce the best mix of both significant coefficients with anticipated effects. Thus for example, average education level has a plausible positive impact when used as a demand instrument, but no significant impact when used on the supply side. Similarly the fraction of the population that is young (1-popover24) works as expected on the supply side but has no impact when included in Demand. The racial variables have similar results with expected supply effects, but no significant impacts when assigned to demand.

Further experimenting was undertaken with respect to the MSA sample. A first test was to restrict the analysis to just MSA with populations of over 400,000. This reduced the sample to just 83 observations and reduced the significance of the results, but qualitatively the conclusions of Tables 2-4 remained. In particular the number of crime

agencies remained significantly negative in both resource and crime equations. In another test we remove those 19 MSA that are effectively suburban-only areas (e.g. Riverside, Bergen-Passaic) and those that have obviously unique crime issues such as resorts (e.g. Atlantic City, Myrtle Beach) and college towns (e.g. Madison, Wisconsin). This had virtually no impact on the results.

Table 4: Violent Crime per capita (Aveviocrm)

Variable	1	2	3	4	5
estimation	OLS	OLS	OLS	IV[1]	IV[2]
constant	-3.9e-03**	1.6e-03**	-4.2e-03*	-7.1e-04	-8.1e-04
Perinc	2.6e-07**	1.9e-07**	3.6e-08		
Pop	8.9e-10**	8.2e-10**	7.5e-10**	1.0e-09**	8.6e-10**
Povrat	2.0e-02**	5.1e-03	9.81e-03*	-7.6e-04	-3.2e-03
criagency	-2.0e-05**	-1.7e-05**	-1.5e-05**	-1.9e-05**	-1.5e-05**
Edu		-4.0e-04	-6.9e-04		
Black	1.0e-04**	1.2e-04**	1.1e-04**	1.4e-04**	1.3e-04**
Hispanic		2.2e-05	1.1e-05	4.0e-05**	3.5e-05**
Landarea		3.9e-09	1.6e-08		
Unemp		1.7e-04**	7.2e-05	1.5e-04**	2.1e-04**
Popover24		-2.9e-06	2.4e-05	-5.0e-05*	2.4e-05
Coolday		4.8e-07**	6.8e-07**	4.9e-07**	3.3e-07*
Wage			7.4e-08**		
Aveexx				-3.8e-00*	2.9e-00
R2	.46	.50	.53	.47	.50

** denotes significant at 5% N = 236

* denotes significant at 10%

[1] Instruments are full list of exogenous variables [2] Instruments exclude wage

The point estimates in Tables 2-4 are stable enough to warrant examining in more detail. A typical large metropolitan area in the US has about 150 law enforcement agencies. Were the cities and towns in such an area to create a single consolidated law enforcement agency, the reduced form point estimates suggest the following ramifications. Law enforcement resources would increase by 33% from the sample mean of .003, property crime would increase by 40% from its mean of .04 and violent crime would increase by 75% from its mean of .004. All of these estimates of course are based on a linear model and we have not experimented with alternative functional forms.

VII. Why does fragmentation reduce spending *and reduce crime?*

The striking result of the empirical research in this paper is the significant and positive co-response of law enforcement spending and crime to jurisdictional fragmentation. Either pattern of negative co-response would be consistent with the theory developed here. Whether resources are lower and crime higher with increased fragmentation, or the reverse, we would interpret the results as identifying the nature of criminal mobility and its impact on local law enforcement effort. The observation that greater fragmentation both reduces crime as well as resources is impossible to explain and simply requires a different model. Reviewing the literature there would seem to be two options.

The first alternative is to hypothesize that a larger number of smaller police departments somehow improves internal police efficiency, that is, "X efficiency". In many ways this is Hoxby's [2000] argument about schools. Pressure and competition from many nearby districts gives parents more options and so school districts operate closer to their production frontier. With law enforcement then it might also be true that the increased Tiebout competition that results with many jurisdictions somehow forces local agencies to operate with less "slack.

A modification of this "efficiency" argument does not involve slack or better resource management, but instead emphasizes "local knowledge" – the basis of the whole "community policing" movement (Wilson [1968]). It could be that small local police departments "get to know" their environs better and this is an important step in controlling crime. In either of these cases, greater fragmentation shifts the criminal supply schedule down (crime on the vertical axis, law enforcement on the horizontal). Moving along the demand schedule, towns decide to spend less and hence both expenditure and crime drop.

Of course if there is some advantage like this, the question is why larger police department don't decentralize more geographically and also reap the rewards. Why cannot a large single police department operate with independent neighborhood units. Isn't that what "precincts" are supposed to do?

The second alternative is a "political economy" story developed almost two decades ago by Behrman and Craig [1987]. They argued that larger police departments

face political pressure to allocate resources more uniformly across neighborhoods than would be dictated purely on efficiency grounds. In their model – in which criminals are *not mobile* - efficiency would dictate strictly putting resources where crime originates. Thus in this model, metropolitan consolidation would lead to more spending in the suburbs, less in the inner city, higher crime and then greater spending overall. These authors present empirical evidence from within the city of Philadelphia that this was the case for resource allocation across precincts. Their model however, does not lend itself to incorporating criminal mobility and criminal mobility is widespread.

If politically induced resource "misallocation" between areas is the explanation for our results then empirical research could examine the actual patterns of spending across jurisdictions. Presumably, MSAs with greater fragmentation would exhibit more variation in law enforcement expenditure. The empirical problem of course would be to disentangle the behavioral effect from the obvious impact that consolidation has by construction when only town level data is available. By definition, a few large police departments have less variation in spending if data is only available at the jurisdictional level. Collecting precinct level data for 235 MSA would be near to impossible. For the moment then, this research has simply uncovered an important empirical observation – one that needs explaining.

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